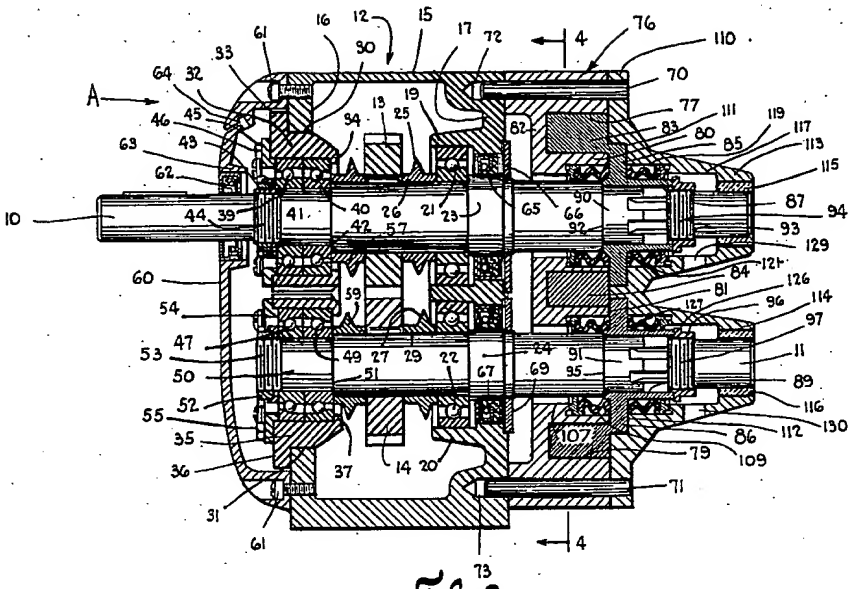
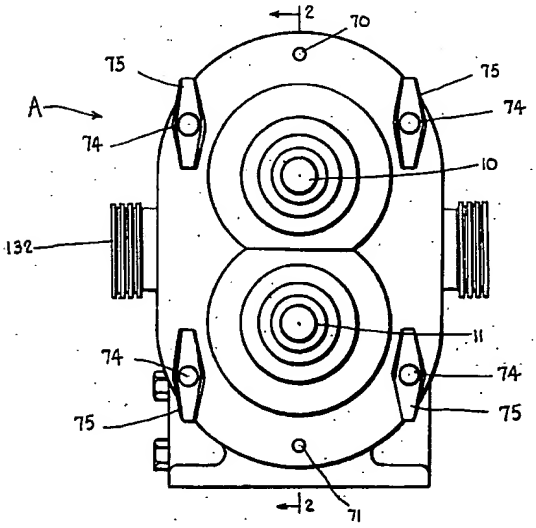
April 7, 1953 F. COLLURA 2,633,807

SANITARY PUMP

Filed June 20, 1947 2 SHEETS—SHEET 1



Fig~2



Fig~1

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SEAL FOR ROTARY FUEL PUMPS

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FIG. 1

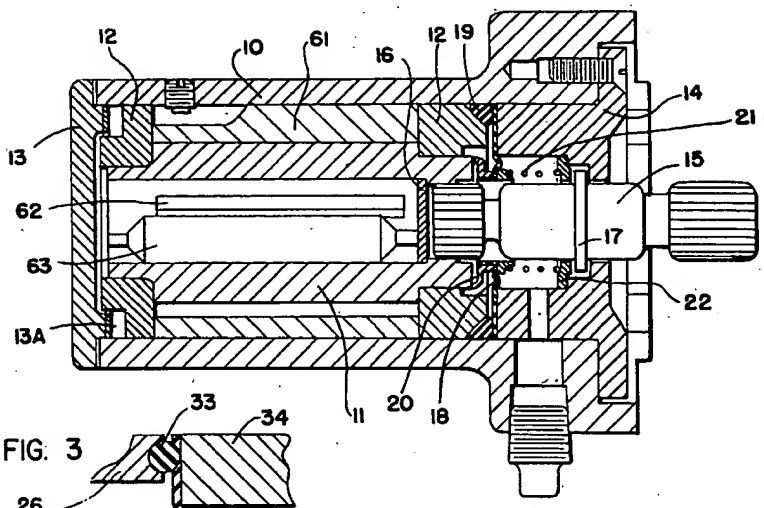


FIG. 3

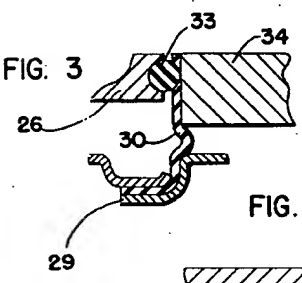
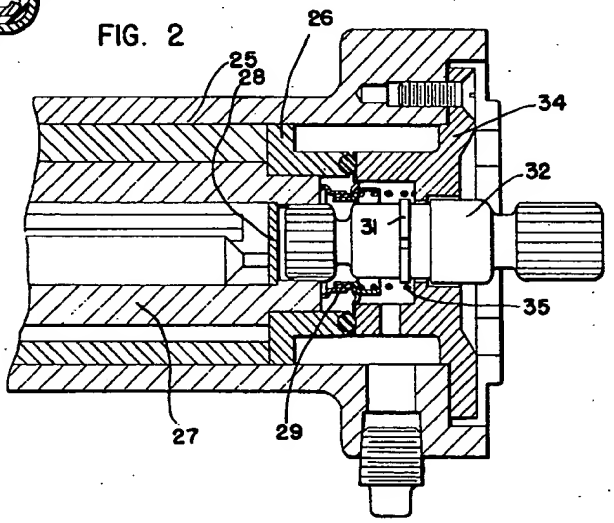


FIG. 2



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March 21, 1961 H. C. OSTERKAMP 2,975,964

ROTARY MACHINE

Filed March 11, 1958 2 Sheets-Sheet 2

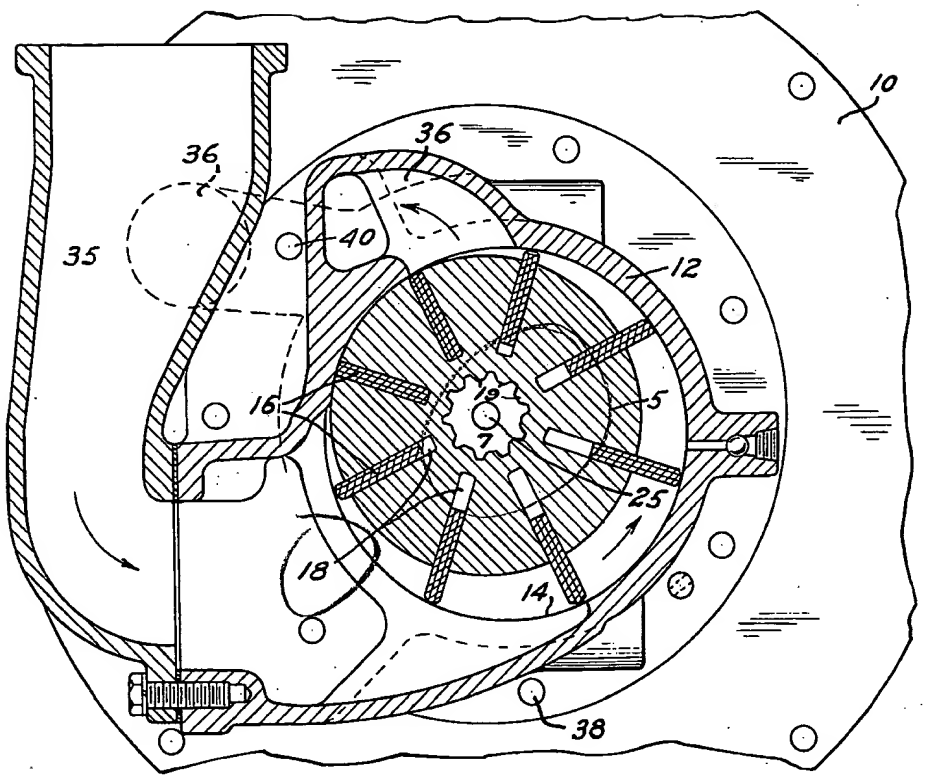

Fig. 2

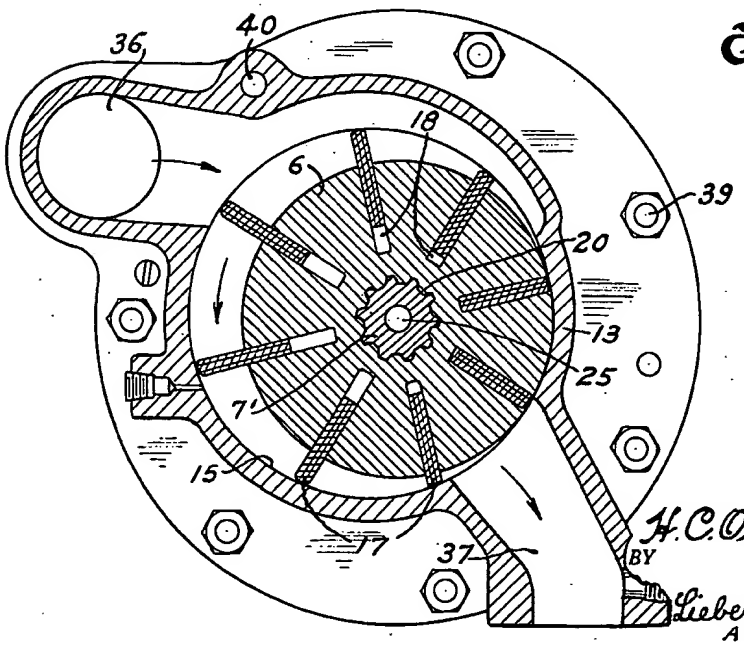

Fig. 3

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United States Patent Office 2,975,964 Patented Mar. 21, 1961

2,975,964

ROTARY MACHINE

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Filed Mar. 11, 1958, Ser. No. 720,603

4 Claims. (Cl. 230—152)

This invention relates in general to improvements in rotary machines, and it relates more specifically to improvements in the construction and operation of rotary machines of the type having a casing provided with a bore and a rotor disposed eccentrically within the casing bore and having a series of outwardly directed vanes cooperable with the bore surface to produce a succession of circumferentially advancing displacement chambers.

The primary object of the present invention is to provide an improved rotary machine of the above mentioned type, which is relatively simple and durable in construction and highly effective in use.

Rotary machines, and especially single stage compressors as well as multi-stage compressors having several stages disposed in axial alinement with each other, and wherein a rotor is revolvably confined eccentrically within and has successive radially slideable vanes cooperable with the bore of a confining casing to provide a circumferential series of displacement chambers, have been proposed and used commercially with varying degrees of success. These machines are ordinarily operable at high speed with the rotor vanes subjected to relatively high pressure, and it is important that the several displacement chambers be well sealed against undesirable leakage and that the end pressures acting upon the rotor be effectively balanced in order to insure maximum efficiency of operation. Considerable wear on the vanes and upon the confining slots of the rotor is naturally bound to occur after periods of prolonged operation of such machines, thus requiring replacement of the vanes and rotor at considerable expense and loss of time due to difficulties in dismantling the prior machines, especially when the body of the rotor had to be renewed. Then too, the prior multi-stage rotary machines of this kind were relatively complicated and did not permit convenient assembly and dismantling of the several coaxial stages independently of each other.

It is therefore an important object of the invention to provide such a high speed rotary machine in which the displacement chambers are most effectively sealed against leakage, and wherein wear on the vanes and rotor can be compensated for at minimum cost and with least delay.

Another important object of the invention is to provide an improved rotary machine assemblage of the above described type, in which the various parts may be readily constructed and assembled or dismantled, and are also effectively balanced and lubricated during normal operation.

A further important object of the present invention is to provide a simplified rotary machine embodying several coaxial stages each comprising a rotor having a series of radially slideable vanes moving along a casing bore disposed eccentrically of the rotor, and wherein each rotor is adapted to float axially relative to and is also removable and reversible independently of the others.

These and other more specific objects and advantages

of the invention will be apparent from the following detained description.

A clear conception of the various features constituting the present improvement, and of the construction and operation of a multi-stage rotary machine embodying the invention, may be had by referring to the drawings accompanying and forming a part of this specification wherein like reference characters designate the same or similar parts in the various views.

Fig. 1 is a central longitudinal vertical section through a two-stage rotary compressor having axially alined adjoining stages each comprising a casing having a bore and a rotor disposed eccentrically within its bore and having a series of radially disposed and slideable vanes adapted to coact with the adjacent bore to provide an annular series of segregated circumferentially advancing displacement chambers; but with the air inlet, transfer and outlet passages omitted for clarity;

Fig. 2 is an enlarged transverse vertical sectional view through the compressor of Fig. 1, taken along the line 2—2 but also showing a portion of the air inlet passage in section and a portion of the compressed air conducting passage connecting the two stages in dash lines; and

Fig. 3 is another enlarged transverse vertical sectional view through the compressor of Fig. 1, taken along line 3—3, and showing the compressed air transfer and outlet passages in section.

While the invention has been specifically illustrated and described herein as being advantageously applicable to multi-stage rotary air compressors, it is in fact more generally applicable to other types of rotary machines of the type hereinabove referred to; and it is also contemplated that specific descriptive terms employed herein be given the broadest possible interpretation consistent with the actual disclosure.

Referring to the drawings, the multi-stage rotary compressor shown therein comprises in general, a pair of coaxial low and high pressure rotors 5, 6 respectively, both adapted to be driven by a common shaft composed of alined sections 7, 7', the rotors 5, 6 being provided with integral opposite end supports which are journalled in end bearings 8, 8' and 9, 9' mounted in end heads 10, 10' and 11, 11' forming closures for annular low and high pressure casing sections 12, 13 having bores 14, 15 disposed eccentrically of the respective rotors 5, 6 and with which radially slideable vanes 16, 17 carried by these rotors are cooperable when the compressor is operating, see Figs. 1, 2 and 3.

As shown in Figs. 2 and 3, the rotors 5, 6 have radial slots 18 formed therein within which the flat vanes 16, 17 are slideable, and the medial central portions of these rotors are provided with annular series of spline projections 19, 20 which are longitudinally slideably engageable respectively with serrations formed on the adjacent ends of the drive shaft sections 7, 7', so that rotary motion will be transmitted from the shaft to the rotors 5, 6 which will be free to move or float along the sectional driving shafts. The section 7 of the drive shaft is provided with an anti-friction thrust bearing 21 mounted in a cap 22 secured to the casing end head 10, while a hollow coupling 7'' which is driven by the spline projections 20 of the rotor 6 is drivingly connected to an auxiliary shaft 23 journalled in another cap 24 secured to the opposite casing end head 11', and the shaft sections 7, 7' are provided with a central passage 25 which is in open communication through the hollow coupling 7'' with a central passage 26 formed in the auxiliary shaft 23.

The bearings 8, 8', 9, 9' which support the rotors 5, 6 in the casing end heads 10, 10', 11, 11' independently of the drive shaft, are all of the anti-friction type and are prefer-

ably of interchangeably similar construction, and the shaft sections 7, 7' are provided with radial ports 28 which connect the central shaft passage 25 with the rotor spline projections 19, 20 and with the bearings 8, 8', 9 while the end bearing 9' is in open communication with the auxiliary shaft passage 26. The end heads 10, 10', 11, 11' of the casing are also provided with annular ducts 29 connecting each bearing 8, 8', 9, 9' with the interiors of the adjacent casing sections 12, 13, and the opposite ends 30, 31 of the respective rotors 5, 6 are spaced slightly from the adjacent end heads and normally cover the ducts 29. The outer end of the auxiliary shaft 23 has an oil pump impeller 32 secured thereto and cooperating with another pump impeller 33 both confined within the end cap 24, and this pump is operable by the main compressor driving shaft and is adapted to constantly deliver oil under pressure through the passages 25, 26, ports 28, bearings 8, 8', 9, 9' and ducts 29 whenever the compressor is operating.

The casing sections 12, 13 are off-set relative to their respective rotors 5, 6 on approximately diametrically opposite sides of the common rotor axis as shown in Fig. 1; and the low pressure section 12 has an air supply or inlet conduit 35 on one side, and an intermediate air transfer conduit 36 on its opposite side in open communication with the corresponding side of the high pressure casing section 13, while the latter has a final compressed air discharge or outlet conduit 37 on its opposite side, as depicted in Figs. 2 and 3. The sections 12, 13 are detachably secured to the adjacent end heads 10, 10', 11, 11' are also properly positioned relative to each other by dowel pins 40 and are sealed at the joints by packing rings 41, and the rotors 5, 6 with their vanes 16, 17 can be readily reversed end to end within their casing sections 14, 15 by merely releasing the cap screws 38 and bolts 39 and sliding the end heads, casing sections and rotors endwise from the shaft sections 7, 7'.

The end head 10 may be detachably mounted upon a rigid support 43 so that the compressor stages are overhung, and the end of the shaft section 7 nearest to the thrust bearing 21 is provided with a pinion 44 meshing with weighted gear 45 detachably secured to a power shaft 46 adapted to be rotated from any convenient source, and the multi-stage compressor unit can obviously be readily removed from the support 43 and from the power shaft 46. The end caps 22, 24 are also detachably secured to the adjacent end heads 10, 11' by cap screws 47 and are sealed against possible leakage by suitable packings, and the lubricant supply and circulation pump at the overhanging end of the unit may also derive its fluid such as oil from any suitable source.

When the improved two stage air compressor has been properly constructed and assembled as above described and is operating normally, the power shaft 46 will constantly rotate the shaft sections 7, 7' and the coupling 7'' at desired speed thereby causing the rotors 5, 6 to rapidly revolve their radial vanes 16, 17 within their respective bores 14, 15. These vanes 16, 17 are constantly urged outwardly by centrifugal force and slide within the rotor slots 18 toward and away from the corresponding bores while coacting therewith to divide the interiors of each casing section 12, 13 into an annular series of displacement chambers which gradually enlarge to draw air therein and subsequently diminish to compress the entrained air during each revolution of the rotors 5, 6. The low pressure rotor 5 initially sucks air into its displacement chambers through the inlet conduit 35 and after partially compressing the entrained air, delivers it into the transfer conduit 36 from whence the partially compressed air passes into the displacement chambers of the high pressure rotor 6 wherein it is finally compressed and from which it is ultimately delivered through the discharge or outlet conduit 37.

While the compressor is functioning in this manner, the rotors 5, 6 are obviously free to float along the common axis of the drive shaft sections 7, 7' due to the spline driving connection afforded by the projections 19 and serrated shaft ends, and the oil pump at the outer overhanging end of the compressor unit will constantly deliver oil under high pressure through the central shaft passages 26, 25 and through the ports 28 past the bearings 8, 8', 9, 9' and through the ducts 29, against the opposite ends of each rotor 5, 6 thereby balancing the end pressures on these rotors. This oil besides effectively lubricating the bearings, also flows through the coupling 7'' and along the shaft sections 7, 7' and lubricates the spline driving connections between these shaft sections and their respective rotors, and the oil escaping through the ducts 29 also serves to lubricate the sliding vanes 16, 17.

After prolonged operation of the compressor and due to the high pressure to which the outwardly projecting and sliding vanes 16, 17 are subjected, both the vanes and the slots 18 within which they are confined, will naturally wear especially along the rear vane surfaces and at the outer reaction edge portions of the slots. If this wear at these localities is permitted to continue until the slots 18 have become enlarged to the extent that the vanes 16, 17 are no longer properly guided, the efficiency of the machine drops considerably and the rotors 5, 6 must be replaced. In accordance with the present improvement, the life of the rotors 5, 6 can be materially prolonged by merely detaching the casing end heads 10', 11' from the adjacent casing sections 12, 13 and by bodily reversing the rotor and vane assemblages, thereby forcing the opposite sides of the vanes 16, 17 against the opposite faces of their confining slots 18 when the rotors 5, 6 are revolved in the proper direction. This reversal may be made with either one or both rotors 5, 6 independently of the other and provides double the wearing area between the coacting rotors and vanes.

From the foregoing detailed description it should be apparent that the present invention in fact provides an improved rotary machine of the type wherein a rotor has an annular series of outwardly projecting and movable vanes slideably cooperable with a casing bore disposed eccentrically of the rotor axis, which is simple, compact and durable in construction and highly efficient in operation. The floating rotors are journalled in the housing independently of the driving shaft and the spline driving connection makes the floating of the rotors and the end balancing thereof possible. The lubrication system also performs the dual purpose of equalizing the pressures on the opposite end of the rotors, and of maintaining all moving parts well oiled; while the formation of the shaft in several sections also facilitates assembly and dismantling of the unit. Such dismantling is also facilitated by mounting the stages at one end and permitting them to overhang, and the invention is obviously advantageously applicable to various kinds of rotary machines.

It should be understood that it is not desired to limit this invention to the exact details of construction and operation of the two-stage compressor herein specifically shown and described, for various modifications within the scope of the appended claims may occur to persons skilled in the art.

I claim:

1. A rotary machine comprising, a casing having a cylindrical bore and spaced end heads coacting therewith to provide a chamber extending axially of the bore, a rotor disposed eccentrically within and extending axially of said bore with its opposite ends spaced slightly from said end heads to provide restricted annular gaps and having an annular series of vanes extending along and disposed radially of the bore axis and constantly snugly slidably cooperable with said bore and with said end heads within said chamber, a shaft extending centrally through said rotor axially of said bore, a motion transmitting con-

nection between said shaft and said rotor formed to permit the rotor to move axially within said chamber between said end heads, supporting bearings for said rotor confined within said end heads and being communicable with the gaps between said rotor ends and the adjacent end heads, and means for forcing liquid under pressure along said bearings and through said end heads and gaps to equalize the end pressures acting upon said rotor.

2. A rotary machine comprising, a casing having a cylindrical bore and spaced end heads coacting therewith to provide a chamber extending axially of the bore, a rotor disposed eccentrically within and extending axially of said bore with its opposite ends spaced slightly from said casing end heads to provide restricted annular gaps and having an annular series of vanes extending along and disposed radially of the bore axis and constantly snugly slidably cooperable with said bore and with said end heads within said chamber, a hollow shaft extending centrally through said rotor axially of said bore, a motion transmitting connection between said shaft and said rotor formed to permit the rotor to float axially within said chamber between said end heads, supporting bearings for said rotor confined within said end heads and being communicable with the gaps between said rotor ends and the adjacent end heads, and means for forcing oil under pressure through said shaft and along said bearings and through said end heads and gaps to equalize the end pressures acting upon said rotor.

3. A rotary machine comprising, several axially alined casings each having a cylindrical bore and spaced end heads coacting therewith to provide alined segregated chambers extending axially of these bores, a rotor disposed eccentrically within and extending axially of each of said bores with its opposite ends spaced slightly from the adjacent casing end heads to provide restricted annular gaps and each having an annular series of vanes extending along and disposed radially of the adjacent bore axis and constantly snugly slidably cooperable with the adjacent bore and with said adjacent casing end heads, a shaft extending centrally through said rotors axially of said bores, a motion transmitting connection between said shaft and each of said rotors formed to permit the rotors to float axially within their respective chambers between the adjacent end heads, supporting bearings for said rotors confined within said adjacent end heads and being communicable with the gaps between said rotor ends and the adjacent end heads, and means for forcing liquid under pressure along said bearings and through said end heads and gaps to equalize the end pressures acting upon each of said rotors.

4. A rotary machine comprising, several axially alined casings each having a cylindrical bore and spaced detachable end heads coacting therewith to provide alined segregated chambers extending axially of their bores, a rotor disposed eccentrically within and extending axially of each of said bores with its opposite ends spaced slightly from the adjacent casing end heads to provide restricted annular gaps and each having an annular series of vanes extending along and disposed radially of the adjacent bore axis and constantly snugly slidably cooperable with the adjacent bore and with said adjacent casing end heads, a shaft extending centrally through said rotors and having axially separable sections within each rotor, and a motion transmitting connection between each shaft section and each of said rotors formed to permit the rotors to float axially within their respective chambers between the adjacent end heads, said rotors being freely independently axially removable from their respective casings upon removal of said end heads and shaft sections.

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